Exemption No. 5078

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
KANSAS CITY, MISSOURI 64106

In the matter of the petition of

BEECH AIRCRAFT CORPORATION

Regulatory Docket No. 071CE

for an exemption from § 23.207 (c)

of the Federal Aviation Regulations

GRANT OF EXEMPTION

By letter dated May 12, 1989, Mr. W.H. Schultz, Division Manager Technical Service and FAA Liaison, Beech Aircraft Corporation, P.O. Box 85, Wichita, Kansas 67201-0085 petitioned for an exemption from § 23.207(c) of the Federal Aviation Regulations (FAR) to permit type certification of the Beech Model 1900D airplane with a stall warning beginning at airspeeds greater than 10 knots or 15 percent above the stalling speed. Mr. Schultz provided additional supportive information by letter dated July 28, 1989.

Section of the FAR affected:

Section 23.207(c) requires the stall warning must begin at a speed exceeding the stalling speed by a margin of not less than 5 knots, but not more than the greater of 10 knots or 15 percent of the stalling speed, and must continue until the stall occurs.

The Petitioner's supportive information is as follows:

The Beech Model 1900D is being developed as a derivative of the Model 1900 certified on Type Certificate A24CE on November 22, 1983. Both the Model 1900 and 1900D certification basis include § 23.207(c), as amended by Amendment 23-7. Since the completion of the certification effort on the Model 1900 aircraft, the FAA has adopted a new policy of showing compliance with this requirement. For the Model 1900, the guidelines for showing compliance with § 23.207(c) were provided by FAA Order 8110.7, FAA Flight Test Guide for Small Airplanes. Paragraph 40a(4) of Order 8110.7 states:

"The stall warning margin between 5 and the greater of 10 knots or 15% of the stall speed is applicable when the speed is reduced at a rate of 1 knot per second with the power off. Stall warning margin in other configurations may not be less than 5 knots above the stall or above a speed at which warning would become objectionable in the normal operating range."

On April 3, 1986, the FAA, Wichita Aircraft Certification Office, sent Beech Aircraft a letter superseding paragraph 40a(4) of FAA Order 8110.7. The superseding text reads:

"The stall warning margin between 5 and the greater of 10 knots or 15% of the stalling speed is applicable when the speed is reduced at the rate of 1 knot per second. Stall warning margin at greater deceleration

rates should not be less than 5 knots above the stall or above a speed at which warning would become objectionable in the normal operating range."

This new paragraph was later incorporated, unchanged, into Advisory Circular 23-8. It is this AC that currently comprises the guidelines and methods for complying with § 23.207(c). Therefore, it is these guidelines that are being used in the Model 1900D certification program. The petitioner contends that complying with § 23.207(c), in accordance with the current guidelines is (1) not in the public interest and (2) would lead to possible compromising or unsafe conditions in certain flight conditions.

Beech proposes that the Model 1900D be exempted from § 23.207(c) and, in the public interest, the aircraft shall comply with the following stall warning requirements:

1. The stall warning must occur at a speed exceeding the stall speed by a margin of not less than 5 knots, but not more than the greater of 10 knots or 15 percent of the stalling speed in the wings-level, power-off, condition at the forward center of gravity (C.G.) at the maximum takeoff and landing weights. This evaluation must be performed at all approved flap settings.

2. The wings-level stall warning must occur at a speed no greater than the maximum speed specified in "1" above at the forward C.G. regardless of weight, the forward C.G. at the maximum takeoff weight, and the aft C.G. at the maximum takeoff weight. This must be shown for power-on and power-off conditions with the flaps in all approved settings. Power-on is defined as 75% of maximum continuous power.

3. The stall warning must occur no less than 5 knots above the actual stalling speed. This must be shown for wings-level flight in the power-on and off conditions, and in 30-degree banked turns to the left and right in the power-on condition.

4. The turning flight stall warning must occur at a speed no greater than the maximum speed specified in "1" above adjusted for the turning flight load factor.

5. In the case where a condition exists such that the pitch control reaches the full-up stop without the aircraft stalling, the stall warning must occur before the pitch control reaches the stop.

6. All stalls, in demonstrating compliance with the above requirements, will be approached at an entry rate of 1 knot per second.

7. The stall warning must, after beginning within the margins specified above, continue until the stall occurs.

Beech submitted very similar petitions for exemption from § 23.207(c) for both the models B300 and 1900D. The petition for the Model B300 cited flight test information on the Beech Model B300 prototype. The Model 1900D prototype is under construction at this time and, therefore, no flight test data is available. However, because of the pertinent similarity between the Model B300 and the Model 1900D, the Model B300 flight test results serve to illustrate Beech's concern regarding compliance with § 23.207(c). The Model 1900D would be expected to have very similar flight characteristics related to stalling speeds, V_{MC} speeds, and associated stall warning. This similarity derives from the basic similarity in the overall configuration, particularly the wing configuration. Both wing planforms are derived from the Model 200 wing so the overall geometry (area, aspect ratio, airfoil sections) is the same. Both designs include using tip extensions and winglets of designs that are exactly the same geometry. While the stalling speed is slightly higher on the 1900D because of its higher weights, the V_{MC} is expected to be the same. The Model 1900D would be expected to show the same capability of flying below the minimum controllable airspeed while approaching a power on stall. Further, the Model 1900D would be expected to have very high deck angles at power on stall conditions at light weight and aft C.G. conditions very similar to those shown in the B300 flight tests.

Beech states that flight testing utilizing the B300 prototype, FA-1, conducted during the month of November 1988, explored the stall warning characteristics of an angle of attack sensing system at various combinations of C.G., weight, flap settings, and landing gear positions. The parameters measured during these tests included, but were not limited to, angle of attack, angle of side slip, airspeed, "G" force, aircraft deck angle, and elevator position. Reduction of this data has shown that trying to produce a stall warning in conjunction with the current requirements would require the utilization of several additional, sophisticated devices, and sensors located throughout the aircraft linked together by a stall warning computer. Assessment of existing and near term technology indicates that such a system at this time appears infeasible. If such a system could be developed it would be less reliable, subject to maintenance error, and require stringent preflight checks not generally performed by pilots of small aircraft. The continuing effort of both pilots and maintenance personnel to ensure proper functioning of such a system and the associated cost would not be in the best interest of the public.

In addition, Beech feels that the installation of the necessary system, if it were able to be developed, would lead to unsafe flight conditions when power-on stalls are encountered. Specifically, given a one-knot-per-second entry rate, the 1900D power-to-weight ratio is large enough that during a power-on stall, the stall warning will not occur until flight deck angles of over 30 degrees are achieved. It is Beech's opinion that, concurrent with the achievement of these flight deck angles, the aircraft attains unusual attitudes which detract from the safety meant to be gained by the stall warning system.

Beech is concerned about the situation where a twin-engine aircraft is allowed to be flown below the minimum controllable airspeed while approaching a power-on stall. Specifically, with an aft C.G. and light weight, the stall speed for the B300 with the flaps in the approach position, landing gear down and 75% power, was found to be approximately 64 knots. As required by § 23.207(c), a stall warning must begin at an airspeed no higher than approximately 74 knots (1.15 times the stall speed). The minimum control speed for the identical configuration is 94 knots. Clearly, the aircraft could be placed in a compromising flight condition should the critical engine fail at the same time or for up to 20 seconds before the stall warning was activated.

Beech asserts that an equivalent level of safety to § 23.207(c) will be established by demonstrating the following flight conditions to ensure no stall warning occurs except as noted:

1. Two-engine takeoff (all approved takeoff flap settings) at the scheduled rotation speed, V_R , minus 5 knots: The climb must be at the minimum scheduled speed, V_2 , to 50 feet above the takeoff surface. The stall warning must not sound during the rotation phase except for a short (approximately one second) duration.

2. One-engine inoperative takeoffs with the critical engine made inoperative at the takeoff decision speed, V_1, and the subsequent takeoff climb accomplished in accordance with the AFM schedule: There must be no stall warning using normal control inputs .

3. Two-engine-approach and landing in accordance with the AFM airspeed schedule minus 5 knots, as required by § 23.153: There must be no stall warning before commencing flare to land.

4. One-engine-inoperative approach and landing at the AFM airspeed schedule: There must be no stall warning before commencing flare to land.

5. Two-engine-approaches and balked-landing climb in accordance with AFM schedule: There must be no stall warning.

Petitioner takes the position that the public interest will be served because they believe that the proposed exemption will enhance safety by providing stall warning margins appropriate for the Model 1900D's

operation. Further, stall warning margins provided by the present § 23.207(c) would lead to possible compromising or unsafe conditions in certain flight conditions.

Comments on published petition summary:

A summary of this petition was published in the FEDERAL REGISTER for public comment on July 11, 1989 (54 FR 29133). The comment period closed July 31, 1989. No comments were received.

The Federal Aviation Administration's (FAA) analysis is as follows:

To obtain the exemption, the petitioner must show, as required by § 11.25(b)(5), that: (1) granting the request is in the public interest, and (2) the exemption would not adversely affect safety, or that a level of safety will be provided which is equal to that provided by the rule from which the exemption is sought.

The FAA has carefully reviewed the information contained in the petitioner's request for exemption.

The petitioner is correct concerning a policy change from FAA Order 8110.7 to Advisory Circular 23-8A on acceptable methods of compliance with the stall warning margin requirement. The policy in FAA Order 8110.7 effectively provided relief from a regulation and since policy cannot relieve a regulation, a change to the policy was in order. The policy change was transmitted to petitioner by a Wichita Aircraft Certification Office letter of April 3, 1986.

Beech cited the complexity of 4 stall warning system that would be necessary for compliance with the applicable requirements and that such a system would tend to be unreliable. The FAA agrees with the need for reliable stall warning systems. The FAA doesn't agree that a complex system is, of necessity, unreliable. The FAA considers the basic issue is to achieve the intended level of safety. With airplanes that incorporate advancements in technology, such as Beech has incorporated in the Model 1900D, the manufacturer may find it necessary to use complex systems for compliance with the applicable requirements. Beech implies the sophisticated system would need stringent preflight procedures and that small airplane pilots do not consistently perform vigorous preflights. The FAA agrees that many pilots' preflight inspections are "less than vigorous". As a result, the FAA typically does not allow credit in system reliability for small airplane preflight checks.

The FAA is aware of the problems being encountered during type certification programs in showing compliance with § 23.207(c) when airplanes with high power-to-weight ratios are being evaluated. This issue was discussed during the Part 23 Airworthiness Review Conference which was held in St. Louis, Missouri, during the week of October 22-26, 1984. It was concluded at that time that § 23.207(c) needs to be revised and the FAA is considering several proposals addressing this issue. The specific upper limits for stall warning margins in the current rule were established in lieu of opening up the upper limit to subjective determinations without specific criteria on which to base those determinations.

Beech cited large cockpit deck angles that can occur before stall warning with the large thrust-to-weight ratios of current airplane designs as a safety consideration in stall warning. The FAA is concerned about these large cockpit deck angles and the characteristics of the affected airplanes in recovering from stalls that occur with such large deck angles. The FAA agrees that evaluations should not be conducted at such large deck angles and that the stall warning margin requirements were not intended for operations involving such large deck angles.

Beech also cited as a safety concern that these multiengine airplanes with high thrust-to-weight ratios, when complying with the applicable stall warning margin requirements, may not have a stall warning in the power-on condition until the airspeed has reduced to a speed well below single-engine failure minimum control speed V_{MC}. The FAA agrees that the power-on stall warning should occur prior to the airplane entering a speed range where engine failure would probably be catastrophic, due to loss of

control of the airplane. However, such a warning system would need to be activated at some margin relative to V_{MC}. Due to variations in V_{MC} with weight and C.G. location, the FAA does not consider requiring the stall warning to occur at or above V_{MC} to be workable. If a warning keyed to V_{MC} becomes necessary, such a warning requirement appears to be an issue independent of the stall warning envisioned in applicable requirements.

Although not addressed specifically by Beech in their supportive information, their proposed stall warning requirement number 5 implies that a 5-knot stall warning would not be required in the condition where the pitch control reaches the full-up stop without the aircraft stalling. Some applicants have contended that stall warning should not be required when the airplane pitch control reaches the full-up stop and the airplane has not exhibited the classic pitch-down motion of aerodynamic wing stall but instead, enters a minimum airspeed condition referred to as V_{MIN}. Some applicants have contended that this condition is not intended by the applicable requirements to be a stall and; thus, stall warning is not required. The FAA has reviewed the definition of a stall in § 23.201 and continues to consider this so-called V_{MIN} condition as a stall condition for the purposes of the regulatory requirements and that stall warning requirements continue to be applicable. Section 23.207 does not exempt any condition defined by § 23.201 as a stall from the applicable requirements for stall warning. However, the FAA agrees that the degree of hazard is far less in such a stall (V_{MIN}) versus a stall where the wing exhibits aerodynamic stall.

The FAA has evaluated each of the specific conditions proposed by the petitioner with respect to assuring a level of safety equivalent to the requirement from which the exemption is sought. Section 23.207(c) includes speed margins such that any other margin does not provide an equivalent level of safety. However, these specific speed margins were selected to achieve the intended level of safety for the airplane envisioned when the rule and its amendments were promulgated. The FAA has concluded that, when compliance is shown with specific conditions set forth as limitations herein, the level of safety intended by § 23.207(c) will be achieved.

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in Sections 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator (14 CFR 11.53), Beech Aircraft Corporation is granted an exemption from § 23.207(c) of the Federal Aviation Regulations to the extent necessary to allow type certification of the Beech Model 1900D airplane without an exact showing of compliance with the requirements of § 23.207(c). For the Model 1900D, this exemption is subject to the following conditions and limitations:

1. The stall warning must begin at a speed exceeding the stalling speed by a margin of not less than 5 knots, but not more than the greater of 10 knots or 15 percent above the wings-level, power-off stalling speed obtained at forward center of gravity (C.G.) and maximum takeoff and landing weights.

2. The wings-level stall warning must be examined at forward C.G. regardless of weight, forward C.G. at maximum takeoff weight, and aft C.G, at maximum takeoff weight to assure that the stall warning will not activate at a speed greater than the maximum speed specified in condition 1 above. This evaluation must be performed power-on and power-off at all approved flap settings.

3. Evaluations must be conducted at each takeoff, landing and approach configuration for which approval is requested to ensure no stall warnings occur except as set forth in the following specific conditions. The following specific conditions must be evaluated:

a. Two-engine takeoff (all approved takeoff flap settings) at scheduled takeoff speed minus 5 knots but not less than V_{MC}: The climb must be at the minimum scheduled speed to 50 feet above the takeoff surface. The stall warning must not activate during the rotation phase except for a short (approximately 1 second) duration prior to achieving liftoff from the takeoff surface.

b. One-engine-inoperative takeoffs with the critical engine made inoperative at the scheduled takeoff speed and the subsequent takeoff climb accomplished in accordance with AFM schedule: There must be no stall warning using normal control inputs.

c. Two-engine approach and landing, in accordance with Airplane Flight Manual (AFM), schedule minus 5 knots as required by § 23.153: There must be no stall warning before commencing the flare to land.

d. One-engine-inoperative approach and landing at the AFM schedule speed minus 5 knots. There must be no stall warning before commencing the flare to land.

e. Two-engine approach and balked-landing climb in accordance with AFM schedule: There must be no stall warning.

4. In all configurations, except those resulting in V_{MIN} (pitch control against upper stop without wing aerodynamic stall), the stall warning must activate 5 knots or more prior to the actual stall. When the airplane configuration is such that the pitch control reaches the full-up stop without the airplane exhibiting a pitch-down motion, the stall warning must sound before the pitch control reaches the stop. This evaluation must be performed with the wings level and with 30-degree banked turns to both the right and left.

5. All stalls in demonstrating compliance with the above requirements must be approached at an entry rate of 1 knot per second.

Issued in Kansas City, Missouri on August 23, 1989.

/s/
Barry D. Clements
Manager, Small Airplane Directorate
Aircraft Certification Service